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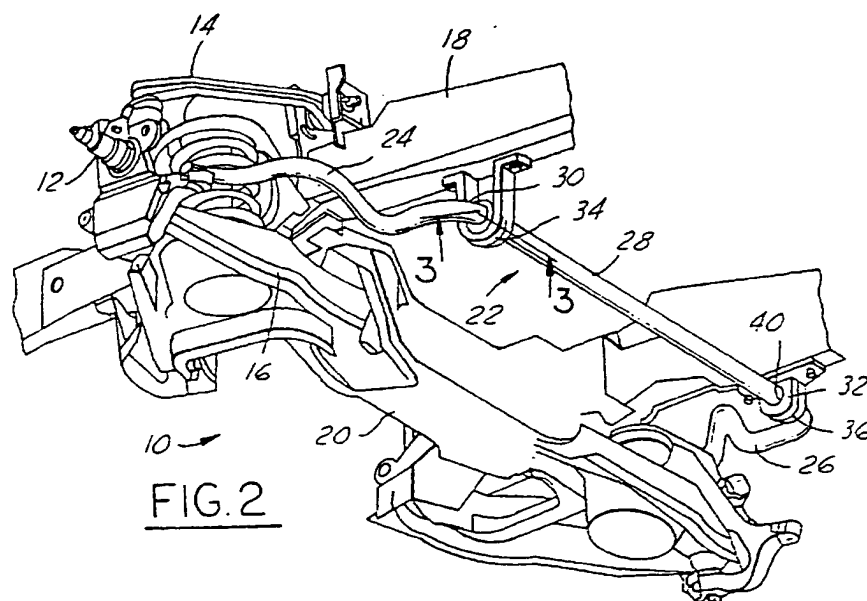
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### (54) A stabiliser bar apparatus for use in a vehicle suspension

(57) A stabiliser bar apparatus for use in a suspension of a motor vehicle includes a hollow tubular member (22) having first and second arms (24,26) disposed at opposite ends of a center section (28). The center section is adapted to be rotatably attached to a chassis and the first and second arms are adapted to attach to first and second wheel suspensions, respectively. A first radial protrusion (38) is circumferentially formed on an

outer surface of the hollow tubular member and extends radially outward from the outer surface to a first predetermined height sufficient to retain the stabilizer bar under lateral loading. Additionally, a stress dispersing formation is (46) formed on an inner surface of the hollow tubular member opposite the first radial protrusion so as to disperse stress that would otherwise concentrate in the hollow tubular member adjacent to the first radial protrusion.



**FIG. 2**

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## Description

[0001] The present invention relates generally to stabilizer bars as used in suspensions for motor vehicles. More particularly the present invention relates to an improved stabilizer bar construction which is lighter and less expensive than previous stabilizer bars providing equivalent functionality.

[0002] It is well known to incorporate integrally forged, radially protruding retention rings on solid stabilizer bars as used in motor vehicle suspensions.

[0003] The integral retention rings eliminate the need to install separate and costly retention collars, as well as the equipment and labor to install them. Finally, the integral retention rings do not have to be aligned by an operator or in service.

[0004] It has also been well known to utilize hollow tubular bars for stabilizer bars to provide a lightweight alternative to solid stabilizer bars. The industry norm for providing lateral retention on hollow stabilizer bars has been to use the more complex and costly retention collars. The additional cost of the retention collars has been considered by the industry to be a necessary compromise to obtain the weight benefits of a lightweight hollow stabilizer bar. The incorporation of integrally forged, radially protruding retention rings on hollow stabilizer bars has been rejected due to the likelihood that the forging process would form a stress riser, as illustrated by area A in FIG. 1, reducing the fatigue performance of the hollow stabilizer bars. This would in turn require thicker hollow stabilizer bars, diminishing the weight benefits originally sought when selecting the hollow bar over a solid bar.

[0005] For these reasons, it would be desirable to provide a stabilizer apparatus constructed from a hollow tubular member and incorporating an integral retention ring to provide a lightweight, cost effective alternative to the stabilizer bars currently available.

[0006] In response to this long felt need, the present invention provides an improvement over both existing solid and hollow stabilizer bars by providing a hollow tubular stabilizer bar having an integrally forged retention ring thereby allowing a lighter and lower cost unit than any of those known heretofore.

[0007] In accordance with the present invention, a stabilizer apparatus for use in a suspension of a motor vehicle has been discovered. The stabilizer bar apparatus includes a hollow tubular member having first and second arms disposed at opposite ends of a center section. The center section is adapted to be rotatably attached to a chassis and the first and second arms are adapted to attach to first and second wheel suspensions, respectively.

[0008] The stabilizer bar apparatus further includes a first radial protrusion circumferentially formed on an outer surface of the hollow tubular member. The first radial protrusion extends radially outward from the outer surface to a first predetermined height sufficient to allow

the first radial protrusion to retain the stabilizer bar within its mounts to the chassis under lateral loading.

[0009] The stabilizer bar apparatus also includes a stress dispersing formation formed on an inner surface of the hollow tubular member opposite the first radial protrusion. This formation disperses stress that would otherwise concentrate in the hollow tubular member adjacent to the first radial protrusion.

[0010] It is an advantage of the present invention to provide a simpler, less expensive and lighter stabilizer bar than was previously available for use in motor vehicle suspensions.

[0011] The invention will now be described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a sectional view taken from a hollow stabilizer bar illustrating stress risers eliminated by the present invention;

FIG. 2 is a perspective view of a frame and suspension for a motor vehicle incorporating a stabilizer bar in accordance with the present invention;

FIG. 3 is a partial sectional view taken along line 3-3 of FIG. 2 illustrating a hollow tubular member constructed in accordance with the present invention;

FIG. 4 is a partial sectional illustrating a hollow tubular member constructed in accordance with the present invention;

FIG. 5 is a partial sectional view illustrating a second embodiment of a hollow tubular member constructed in accordance with the present invention;

FIG. 6 is a partial sectional view illustrating a third embodiment of a hollow tubular member constructed in accordance with the present invention;

FIG. 7 is a partial sectional view illustrating tubular member loaded into a forming tool prior to being formed in accordance with the present invention;

FIG. 8 is a partial sectional view illustrating tubular member after being formed by a forming tool in accordance with the present invention;

FIG. 9 is a partial sectional view illustrating tubular member after being formed by a forming tool in accordance with a second embodiment of the present invention;

FIG. 10 is a partial sectional view illustrating tubular member after being partially formed by a forming tool in accordance with a third embodiment of the present invention; and

FIG. 11 is a partial sectional view illustrating tubular member after being formed by a forming tool in accordance with a third embodiment of the present invention.

[0012] Referring now to FIG. 2, a typical vehicle suspension system 10 is shown including a wheel support member 12 for rotatably supporting a road wheel (not shown). For clarity and brevity, only the front left side of

the suspension will be described, it being understood that the suspension is generally symmetric, with similar parts being found on a right side of the vehicle. Additionally, the present invention applies equally to front or rear suspensions. Upper and lower control arms 14, 16 are pivotally attached to a longitudinal frame member 18 of the vehicle chassis. A cross member 20 is shown interconnecting two longitudinal frame members.

**[0013]** It should also be noted that the present invention will be described in relation to a vehicle having body on frame construction, however, the present invention applies equally to a motor vehicle having a unibody structure wherein side rails, alone or in combination with a sub-frame, provide the structural support provided by the longitudinal frame members illustrated and they are constructed as integral components of the floor pan.

**[0014]** A stabilizer bar 22 includes first and second arms 24, 26 extending from opposite ends of a center section 28. The first and second arms 24, 26 attach to right and left suspensions, preferably to the wheel support member 12 as shown, or as far outboard on the lower control arms as possible. First and second bushings 30, 32 are rotatably affixed to the center section 28 of stabilizer bar 22 and supported from the longitudinal frame members by first and second clamps 34, 36. First and second radial protrusions 38 (see FIG. 3), 40 disposed inboard of the first and second bushings 30, 32 serve as assembly aids as well as to center the center section 28 laterally during operation.

**[0015]** Referring now to FIGS. 3 and 4, the stabilizer bar 22 is preferably constructed using a hollow tubular member having an inner surface 42 and an outer surface 44 and predetermined outer diameter and thickness determined depending on specific vehicle characteristics, as is well known to those skilled in the art. The first radial protrusion 38 takes the form of a ring around the entire circumference of the outer surface 44 of the hollow tubular member. The first radial protrusion 38 extends radially outward from the outer surface a predetermined height,  $h_1$ , sufficient to maintain the tubular member relative to the bushing 34.

**[0016]** The stabiliser bar 22 also includes a formation on the inner surface of the hollow tubular member adjacent to, or opposite from, the first radial projection 38 having a geometric shape that reduces or disperses stress that might otherwise concentrate in this region under repeated torsional loading of the tubular member. In the first embodiment illustrated, this formation takes the shape of a second radial protrusion 46 extending radially inward around the entire circumference of the inner surface 42 of the hollow tubular member. The second radial protrusion 46 may be of similar width and height as the first radial protrusion 38, however it is not necessary. The second radial protrusion 46 further includes a first radius,  $R_1$ , in establishing the transition between the inner surface of the hollow tubular member and second radial protrusion 46. The first radius,  $R_1$ , should be greater than a first predetermined minimum

dimension to prevent stress from concentrating in the hollow tubular member adjacent to the first and second radial protrusions. The first predetermined minimum dimension should be determined for a given vehicle and tubular member thickness and diameter.

**[0017]** Referring now to FIG. 5, an alternative embodiment is illustrated, wherein the formation takes the shape of a first circumferential channel 50 extending radially outward around the entire circumference of the inner surface 42 of the hollow tubular member. The first circumferential channel 50 includes an arcuate bottom surface 52 characterized by a second radius,  $R_2$ , having a second predetermined minimum dimension. A third radius  $R_3$ , located between the inner surface 42 of the hollow tubular member and the arcuate bottom surface 52 also has a third predetermined minimum dimension. The second and third predetermined minimum dimensions should be determined for a given vehicle and tubular member thickness and diameter so as to prevent stress from concentrating in the hollow tubular member adjacent to the first and second radial protrusions.

**[0018]** Referring now to FIG. 6, yet another alternative embodiment is illustrated, wherein the first radial protrusion 38 includes a ramp portion 56 gradually departing outwardly from the outer surface 44 of the hollow tubular member. In the presently preferred embodiment, the ramp departure angle is approximately forty-five degrees. The ramp portion 56 terminates at the intersection with an wall portion 58 extending outwardly and substantially normal to the outer surface 44 of the hollow tubular member.

**[0019]** The formation for the embodiment illustrated in FIG. 6 takes the shape of a second circumferential channel 60 extending radially outward around the entire circumference of the inner surface 42 of the hollow tubular member. The second circumferential channel 60 includes a first side 62 substantially parallel to the ramp portion 56 and a second side 64 substantially parallel to the wall portion 58 and is characterized by fourth, fifth and sixth radii,  $R_4, R_5, R_6$ . The fourth radius,  $R_4$ , is located between the inner surface 42 of the hollow tubular member and the first side 62 and has a fourth predetermined minimum dimension. The fifth radius,  $R_5$ , is located between the inner surface 42 of the hollow tubular member and the second side 64 and has a fifth predetermined minimum dimension. The sixth radius,  $R_6$ , is located between the first side 62 and the second side 64 and has a sixth predetermined minimum dimension. The fourth, fifth and sixth predetermined minimum dimensions should be determined for a given vehicle and tubular member thickness and diameter so as to prevent stress from concentrating in the hollow tubular member adjacent to the first and second radial protrusions.

**[0020]** Referring now to FIGS. 7-11, a method of forming a stabilizer bar in accordance with the principles of the present invention will now be described. The hollow tubular member 22 is loaded and clamped into a tool 70 having two axially movable platens 72, 74. The platens

clamp the hollow tubular member with sufficient force to prevent movement of the platens relative to the tubular member during the forming operation. The facing ends 76, 78 of the platens include over-bored regions 80, 82 having a predetermined diameter and depth depending on which embodiment is desired. FIGS. 10 and 11 show that one is over-bored larger than the other in order to form the third embodiment described above and shown in FIG 6.

**[0021]** Generally, once clamped as shown in FIG 6, a dc current is conducted through the hollow tubular member 22 between the platens, which preferably are also operative as electrodes, sufficient to reach a preferred forging temperature of approximately 1700 degrees Fahrenheit. While heated, the platens are stroked toward one another a predetermined distance, as in FIGS 8-11, again depending on the embodiment desired and the diameter and thickness of the bar. The tube bulges forming the first radial protrusion 38 and the desired formation on the inner surface 42 of the hollow tubular member.

**[0022]** It is generally desirable to form the hollow tubular member 22 from a seam welded tubular member, although, a seamless DOM tubular member as well as a tubular member formed by other known manufacturing techniques would provide equivalent operability. In the presently preferred embodiment of the invention, the tubular member is constructed from steel such as SAE 4130 and having an outer diameter in the range of 18mm - 50mm and a thickness in the range of 10%-25% of the outer diameter.

#### Claims

1. A stabiliser bar apparatus for use in a suspension of a motor vehicle, said stabilizer apparatus comprising:

a hollow tubular member (22) having first and second arms (24,26) disposed at opposite ends of a center section (28), said centre section (28) being adapted to be rotatably attached to a chassis and said first and second arms (24,26) being adapted to attach to first and second wheel suspensions;

a first radial (38) protrusion circumferentially formed on an outer surface (44) of said hollow tubular member (22), said first radial protrusion (38) extending radially outward from said outer surface (44) to a first predetermined height; and a second radial protrusion (46) circumferentially formed on an inner surface (42), extending inwardly therefrom and having a first radius between said inner surface (42) of said hollow tubular member (22) and said second radial protrusion (46), said first radius having a first predetermined minimum dimension so as to prevent

vent stress from concentrating in said hollow tubular member (22) adjacent to said first radial protrusion (38).

2. A stabiliser bar apparatus according to Claim 1, wherein said first radial protrusion is formed on said outer surface of said center section.
3. A stabiliser bar apparatus for use in a motor vehicle having a chassis and a suspension, said stabilizer apparatus comprising:

a hollow tubular member having first and second arms disposed at opposite ends of a center section, said first and second arms being attached to first and second suspension;

first and second bushings rotatably disposed on said center section of said hollow tubular member and being securely clamped to said chassis;

a plurality of radial protrusions circumferentially formed on an outer surface of said center section of said hollow tubular member adjacent to said first and second bushings, each of said radial protrusions extending radially outward from said outer surface to a first predetermined height; and

a plurality of stress dispersing means formed on an inner surface of said hollow tubular member opposite each of said radial protrusions, said means for dispersing stress otherwise concentrated in said hollow tubular member adjacent to each of said radial protrusions.

4. A stabiliser bar apparatus according to Claim 3, wherein each of said stress dispersing means further comprise a second radial protrusion circumferentially formed on an inner surface of said hollow tubular member, said second radial protrusion extending radially inward from said inner surface.

5. A stabiliser bar apparatus according to Claim 4, wherein said stress dispersing means further comprises a first radius between said inner surface of said hollow tubular member and said second radial protrusion, said first radius having a first predetermined minimum dimension so as to prevent stress from concentrating in said hollow tubular member adjacent to said plurality of radial protrusions.

6. A stabiliser bar apparatus according to Claim 3, wherein each of said stress dispersing means further comprise a first circumferential channel formed on an inner surface of said hollow tubular member, said first circumferential channel having an arcuate bottom surface characterized by a second radius having a second predetermined minimum dimension so as to prevent stress from concentrating in

said hollow tubular member adjacent to said plurality of radial protrusions.

7. A stabiliser bar apparatus according to Claim 6,  
wherein said first circumferential channel further  
comprises a third radius between said inner surface  
of said hollow tubular member and said arcuate bot-  
tom of said first circumferential channel, said third  
radius having a third predetermined minimum di-  
mension so as to prevent stress from concentrating  
in said hollow tubular member adjacent to said plu-  
rality of radial protrusions. 5 10
  
8. A stabiliser bar apparatus according to Claim 3,  
wherein said first radial protrusion further compris-  
es a ramp portion gradually departing from said out-  
er surface and intersecting a wall portion extending  
outward and substantially normal to said outer sur-  
face to said first predetermined height. 15 20
  
9. A stabiliser bar apparatus according to Claim 8,  
wherein each of said stress dispersing means fur-  
ther comprise a second circumferential channel  
formed on an inner surface of said hollow tubular  
member, said second circumferential channel hav-  
ing a first side parallel to said ramp portion and a  
second side parallel to said wall portion. 25
  
10. A stabiliser bar apparatus according to Claim 10,  
wherein said second circumferential channel fur-  
ther comprises: 30
  - a fourth radius between said inner surface of  
said hollow tubular member and said first side  
of said second circumferential channel, said  
fourth radius having a fourth predetermined  
minimum dimension; 35
  - a fifth radius between said inner surface of said  
hollow tubular member and said second side of  
said second circumferential channel, said fifth  
radius having a fifth predetermined minimum  
dimension; and 40
  - a sixth radius between said first side of said  
second circumferential channel and said sec-  
ond side of said second circumferential chan-  
nel, said sixth radius having a sixth predeter-  
mined minimum dimension so as to prevent  
stress from concentrating in said hollow tubular  
member adjacent to said plurality of radial pro-  
trusions. 45 50

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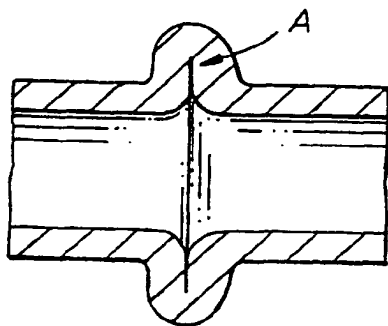


FIG. 1

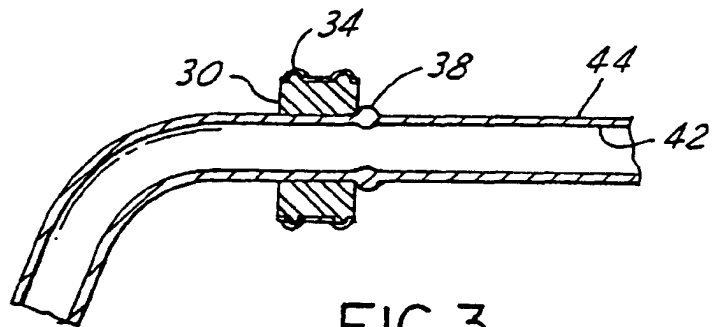


FIG. 3

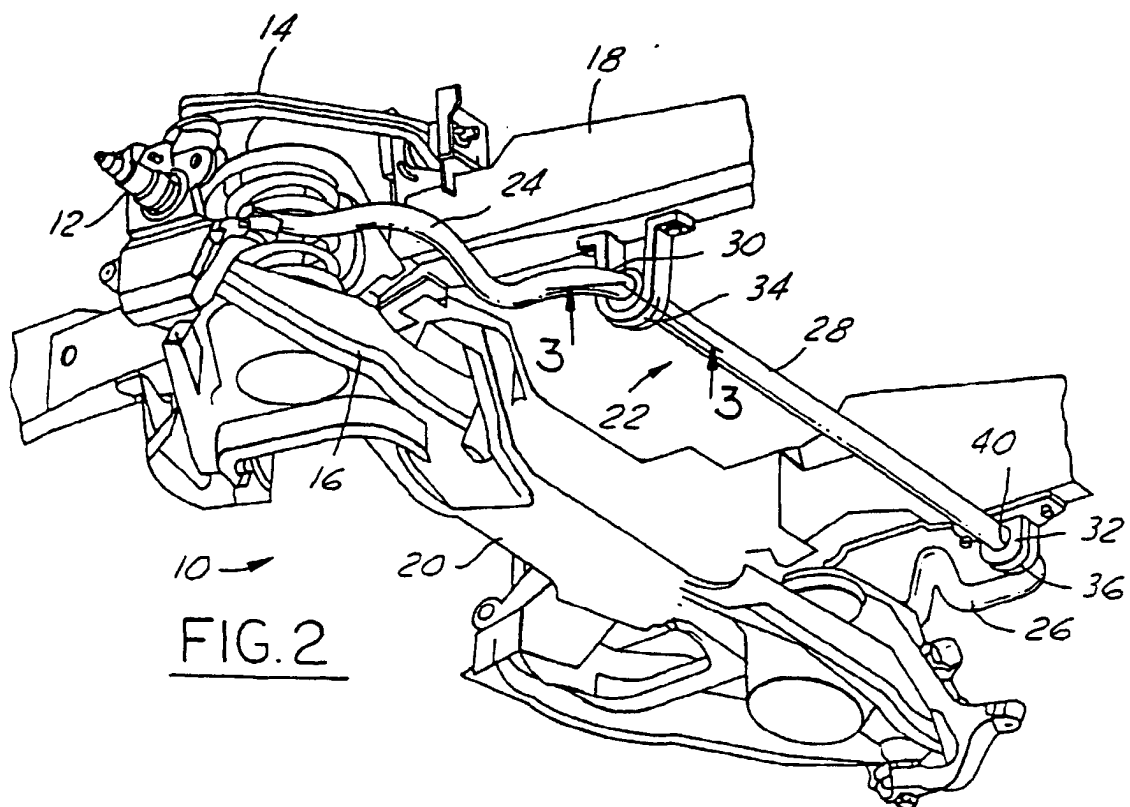


FIG. 2

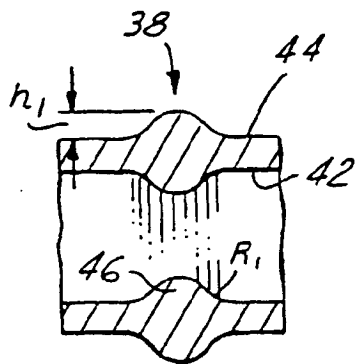


FIG. 4

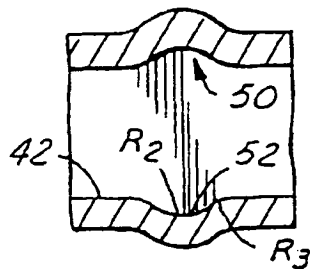


FIG. 5

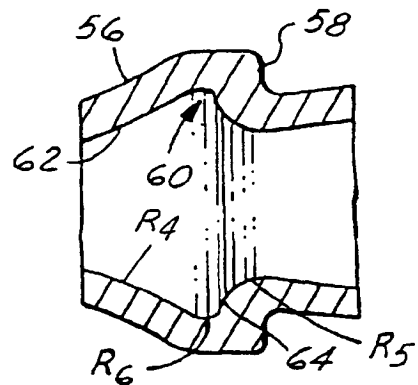


FIG. 6

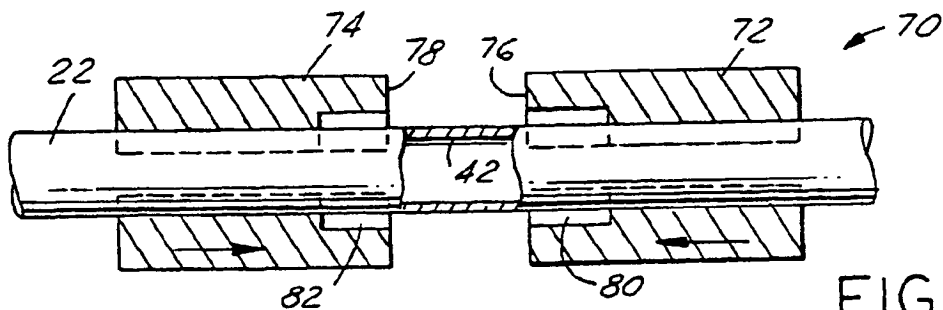


FIG. 7

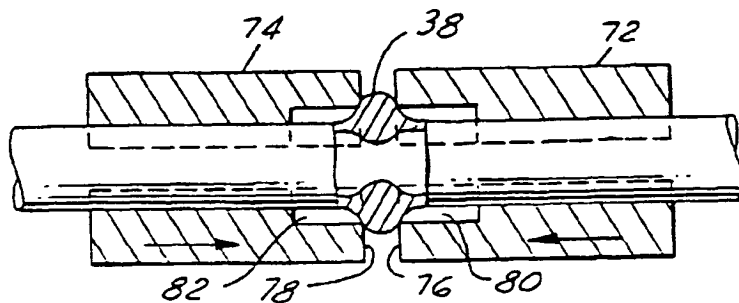


FIG. 8

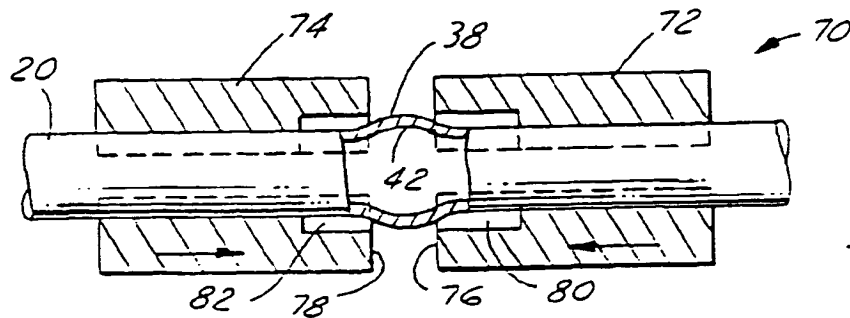


FIG. 9

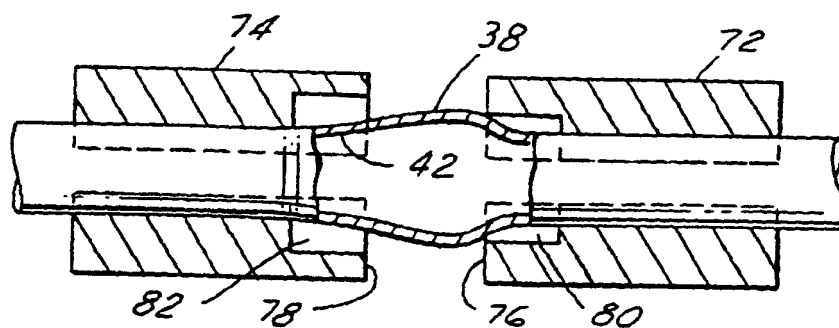


FIG. 10

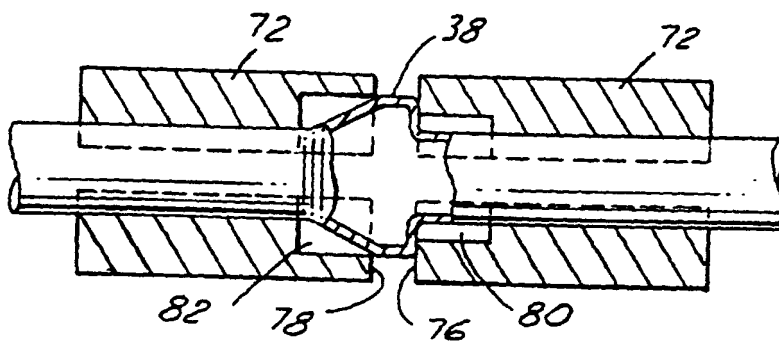


FIG. 11





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## EUROPEAN SEARCH REPORT

Application Number

EP 99 30 3681

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	FR 2 718 391 A (ALLEVARD SA) 13 October 1995 (1995-10-13) * page 4, line 14 - page 5, line 2; claims 1,10,13,14; figures *	1-4,8	B60G21/055 F16F1/14 B21D53/88 B21D17/02 B21J9/08 B21C37/16
Y	EP 0 157 894 A (HITACHI LTD) 16 October 1985 (1985-10-16) * abstract; figures *	1-4,8	
Y	PATENT ABSTRACTS OF JAPAN vol. 013, no. 094 (M-804), 6 March 1989 (1989-03-06) & JP 63 287616 A (MAZDA MOTOR CORP), 24 November 1988 (1988-11-24) * abstract; figures 1,2 *	3,6	
Y	US 5 522 247 A (MITSUBAYASHI MASAHIKO ET AL) 4 June 1996 (1996-06-04) * abstract; figures 1-3 *	3,6	
A		1,2	
Y	PATENT ABSTRACTS OF JAPAN vol. 018, no. 524 (M-1682), 4 October 1994 (1994-10-04) & JP 06 182456 A (TOYOTA MOTOR CORP), 5 July 1994 (1994-07-05) * abstract; figures *	3,6	TECHNICAL FIELDS SEARCHED (Int.Cl.6) B60G F16F B21D B21J B21C
A		1,2	
Y	WO 91 13707 A (OVAKO OY) 19 September 1991 (1991-09-19) * abstract; figures *	3,6	
A	EP 0 672 475 A (DAIWA HOUSE INDUSTRY CO LTD ;DAI ICHI HIGH FREQUENCY CO LTD (JP)) 20 September 1995 (1995-09-20) * abstract; figures 1-19 *	1-4,8	
	-/--		
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		13 September 1999	Tsitsilonis, L
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## EUROPEAN SEARCH REPORT

Application Number  
EP 99 30 3681

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	WO 85 00023 A (ENACO AUSTRALIA PTY LTD) 3 January 1985 (1985-01-03) * the whole document *	1-4,8	
A	DE 41 04 707 A (BRUECK BRUNO JAKOB) 20 August 1992 (1992-08-20) * abstract; figures *	1-3	
A	EP 0 496 949 A (PORSCHE AG) 5 August 1992 (1992-08-05)		
A	PATENT ABSTRACTS OF JAPAN vol. 097, no. 007, 31 July 1997 (1997-07-31) & JP 09 058246 A (TUBE FORMING:KK), 4 March 1997 (1997-03-04) * abstract *		
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
Place of search <b>THE HAGUE</b>		Date of completion of the search <b>13 September 1999</b>	Examiner <b>Tsitsilonis, L</b>
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EP 99 30 3681

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13-09-1999

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 2718391 A	13-10-1995	NONE	
EP 0157894 A	16-10-1985	US 4625533 A	02-12-1986
JP 63287616 A	24-11-1988	NONE	
US 5522247 A	04-06-1996	JP 2874532 B	24-03-1999
		JP 7088566 A	04-04-1995
JP 06182456 A	05-07-1994	JP 2874494 B	24-03-1999
WO 9113707 A	19-09-1991	FI 901113 A	06-09-1991
		AT 117225 T	15-02-1995
		AU 7449391 A	10-10-1991
		DE 69106872 D	02-03-1995
		DE 69106872 T	31-08-1995
		EP 0518929 A	23-12-1992
		US 5491996 A	20-02-1996
EP 0672475 A	20-09-1995	JP 2614417 B	28-05-1997
		JP 8007635 A	12-01-1996
		AU 685878 B	29-01-1998
		AU 1004495 A	03-08-1995
		CA 2139829 A	25-07-1995
		JP 2821095 B	05-11-1998
		JP 7292771 A	07-11-1995
		US 5713130 A	03-02-1998
WO 8500023 A	03-01-1985	EP 0153323 A	04-09-1985
		AU 3061784 A	11-01-1985
DE 4104707 A	20-08-1992	NONE	
EP 0496949 A	05-08-1992	DE 4102823 A	06-08-1992
		DE 59103989 D	02-02-1995
JP 09058246 A	04-03-1997	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office. No. 12/82

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